NEWS AND NOTES

Underwater Sounds of Southern Right Whales

(Plate I; Text-figures 1-2)

Long, repeated vocalizations are made by two species of baleen whales, *Megaptera novaeangliae* (Payne and McVay, 1971) and fin whales, *Balaenoptera physalis* (Walker, 1963; Walker, 1964; Patterson and Hamilton, 1964; Schevill, Watkins, and Backus, 1964; Weston and Black, 1965; Kibblewhite, Denham, and Barnes, 1967; Northrup, Cummings, and Thompson, 1968). A preliminary study of the vocalizations of a third baleen whale species, the southern right whale *Eubalaena glacialis,* is reported here.

On the basis of a report from the R/V Hero (Gilmore, 1969), the New York Zoological Society sponsored a preliminary study of a small concentration of southern right whales near Peninsula Valdez, off the coast of Argentina in September 1970. The purpose of this study was to record their vocalizations and to lay the groundwork for a more prolonged study of their behavior in subsequent years, should their location prove amenable to such studies. This paper will be concerned with their sounds.

During approximately 12 hours of recording from a 4-meter boat within one kilometer of a group of whales, a variety of sounds in the range audible to humans were recorded. Some of them are extremely similar to sounds recorded from right whales by Schevill and coworkers (Schevill and Watkins, 1962 (record); Schevill, 1962 (*Oceanus*); Schevill, Backus, and Hersey, 1962). In fact, the first and second sounds in Group B which we present here are almost identical to a spectrogram given by Schevill (1962), and again by Schevill and Watkins (1962).

On the other hand, the sounds that we recorded differ considerably from the sequential sounds in "stanzas" presented as right whale sounds by Cummings and Philippi (1970) (their basis for species identifications is not indicated). Some of their spectrograms are very similar to spectrograms of our recordings of the lowest humpback whale vocalizations. Since their recorder was limited to frequencies below 175 Hz, many frequency components of the true sonic emissions may be missing in their spectrograms. The periods of silence between bouts of low sounds in their records correspond appropriately to bouts of higher frequency sounds in humpback songs—signals which would have been too high to have been recorded by Cummings and Philippi. It seems possible, therefore, that these sounds could have been made by humpback whales.

Our sample of right whale sounds comes from about nine hours recorded in early afternoon on three different days, and three hours recorded one night. We recorded the kinds of sound described here both in open ocean and in an enclosed bay. In all cases our hydrophones were within one kilometer of a group of right whales. In the daytime the sounds were infrequent, about one isolated sound per half hour. The sample recorded at night shows at least one sound every minute, and occasionally clusters of up to 15 sounds per minute. We do not know whether the increased vocal activity at night was accompanied by increased physical activity.

Pronounced differences in intensity of adjacent sounds in some of our recordings suggest to us that several whales were vocalizing at different distances from the hydrophone. Some sounds occurred in groups, the components being a few seconds apart and roughly equal in intensity, with a typical group lasting no more than one minute, and containing up to 15 sounds. It seems likely that all the sounds in such a group were made by one whale. Single utterances surrounded by long silences were also common.

In no case did we hear a long, continuous, patterned sequence of sounds, and we concluded that the whales were not singing songs at this time (late September) and place. However, this does not necessarily imply that these whales do not sing at other times of year. For example, although the songs of humpback whales can be heard almost constantly in the waters near Bermuda during April and May, the humpbacks that feed in New England waters have not been heard singing songs during the summer and fall (Schevill, 1964). During that period, only less highly organized, more isolated vocalizations have been recorded. The same sort of pattern could exist in right whales, and the fact that the nonrepetitive organization of right whale sounds we report here does not parallel humpback

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songs or the stanzas which Cummings and Philippi describe for right whales does not mean that such stanzas or songs are not sung by right whales.

The samples shown here were recorded between 1 a.m. and 4 a.m. on September 23, 1970, with a hydrophone which hung over the side of a small boat. The hydrophone was amplified and played in to one channel of a Sony 770-2 tape recorder. The recording apparatus was uniform in response within ±2 dB from 20 Hz to 15 kHz. Spectrograms were made on a Kay model 7029A spectrograph.

The recordings contain much wave- and boat-generated noise, seen as vertical bands on the spectrograms. Text-fig. 2 is a tracing of the spectrograms in Text-fig. 1, made to guide the reader to the whale-generated sounds among the noise. Since many structural details in the spectrograms are lost in noise, especially when the sounds are pulsive, these tracings are quite subjective. They do not substitute for spectrograms and are only intended to indicate the general nature of each sound, to draw attention to the fundamental frequency of tonal sounds, and (by omission) to identify artifacts. We have left out all harmonics except in the case of sounds which are pulsive or rasping and which therefore must depend heavily on their harmonic structure for their acoustic effect on the human ear. We hope thereby to make clear the major features of our categories of different types of sounds.

Group A and Group B show the units in two groups of sounds. The numbers between the spectrograms indicate intervals of silence (in seconds) between the end of one sound and the beginning of the next. Five sounds were omitted from Group A because they were much weaker and contained fewer high harmonics than similar sounds in other groups, and thus were judged to come from a more distant whale. (The missing sounds occurred between the first and second spectrograms, the second and third, the eighth and ninth, and the ninth and tenth [two sounds]). No sounds were omitted from Group B.

Examples C, D, and F show isolated sounds which (as far as we can hear from the recording) were surrounded by three to 30 minutes of silence. The most common type of isolated sound in our sample is exemplified by D and E. E′ is a spectrogram of the sound in E, shown on an expanded scale.

The briefest overall examination of the sample spectrograms shows that the vocabulary of these whales is complex, even in such a small sample (in fact our sound types may prove to be points along a continuum). The units in a group of sounds differ from each other in form and in the amount of time that separates them. The organization of units within a group does not seem to be stereotyped.

In frequency, most of the sounds seem to lie between 50 Hz and 500 Hz, but occasional clear sounds as high as 1500 Hz were heard: two examples are shown in spectrograms C and I. Schevill, Backus, and Hersey (1962) reported no fundamental frequencies over about 400 Hz in *Eubalaena glacialis* near Cape Cod and, as mentioned, the hydrophone used by Cummings and Philippi was insensitive above 175 Hz. While it is possible that some other source was responsible for the 1500 Hz sounds we recorded, they were present in the same times, places, and rough relative intensities (subjective interpretation) as the lower sounds, and they sometimes occurred in groups whose other components were low sounds. The evidence suggests that both the high and low sounds were made by right whales.

The frequency span of each sound is narrow (usually less than one octave) but the differing harmonic structure adds much variety to the sounds. There are constant fluctuations between pulsive sounds (i.e., sounds rich in harmonics, giving a rasping, atonal quality), and simpler sounds containing a recognizable, clear pitch.

The bottom line of Text-figure 1 and Text-figure 2 gives samples of different types of sounds, with units II, III, IV, and VI presented on an expanded time scale to show the pulsive structure better. Some sounds seem to be entirely nonpulsive (e.g., I; also C, and the first unit in Group B). Some start as tonal and end rasping (e.g., II; also the third unit in Group A). Some start pulsive or rasping and end more tonal (e.g., III; also the fifth unit in Group B). Others start and end pulsive with a tonal section in the middle (e.g., IV). Still others have a clear pitch at the beginning and ending and a pulsive section in the middle (e.g., V). Some are pulsive throughout (e.g., VI). Some seem to have more than one fundamental, and a correspondingly complex harmonic structure (e.g., VII), but better signal-to-noise ratios are needed to confirm this. As both Group A and Group B indicate, many types of structure may be included in a group of sounds.

The function of these sounds is not known. The whales kept in a fairly close group including both mature and very young animals, and much social activity was going on. In one area there were cliffs from which we were able to observe clearly through the water the behavior of whales swimming directly beneath us. We witnessed on three occasions what appeared to be postural behavior that occurred on meeting. Having once seen it at close range, we could see that it often occurred when two whales met. In all three instances in which we saw it clearly, a whale lying motionless at the surface of the water with its back exposed was approached slowly (at less than 1 km/hour) from the rear by a deeper whale. As the approaching whale passed beneath, the stationary whale flexed its spine so it curved laterally while it was also thrown into a sinusoidal curve in the vertical plane—a very strange and awkward movement visible from far away. Such a greeting is shown in the three photographs of Plate 1. In addition to this greeting ceremony, we also watched what we believe to be feeding, nursing, mating* and frequently playing—sometimes between mother and yearling calf (age judged by size), but more often by a calf alone. We never observed play between two calves, even during what seemed like a likely occasion when two adults, each with young, lingered next to each other for about two hours.

Summary

Underwater recordings made near several groups of right whales show a variety of sounds, principally in the range 50 Hz to 500 Hz but including some as high as 1500 Hz, not previously reported for this species. The frequency range of each sound is narrow, but the harmonic structure of some is complex. Both single sounds and sounds occurring in groups lasting up to one minute were recorded. The irregular and nonrepetitive organization of sounds in groups indicates that these are not "songs," and different intensities in adjacent sounds suggests that more than one whale was involved. Vocal activity was greater at night than in daytime. Some behavioral observations were made.

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* A paper describing these activities is in preparation as part of a planned intensive program over the next few years to extend these observations in the same area, while making simultaneous sound recordings, and to attempt to link some of the sounds to behavior.

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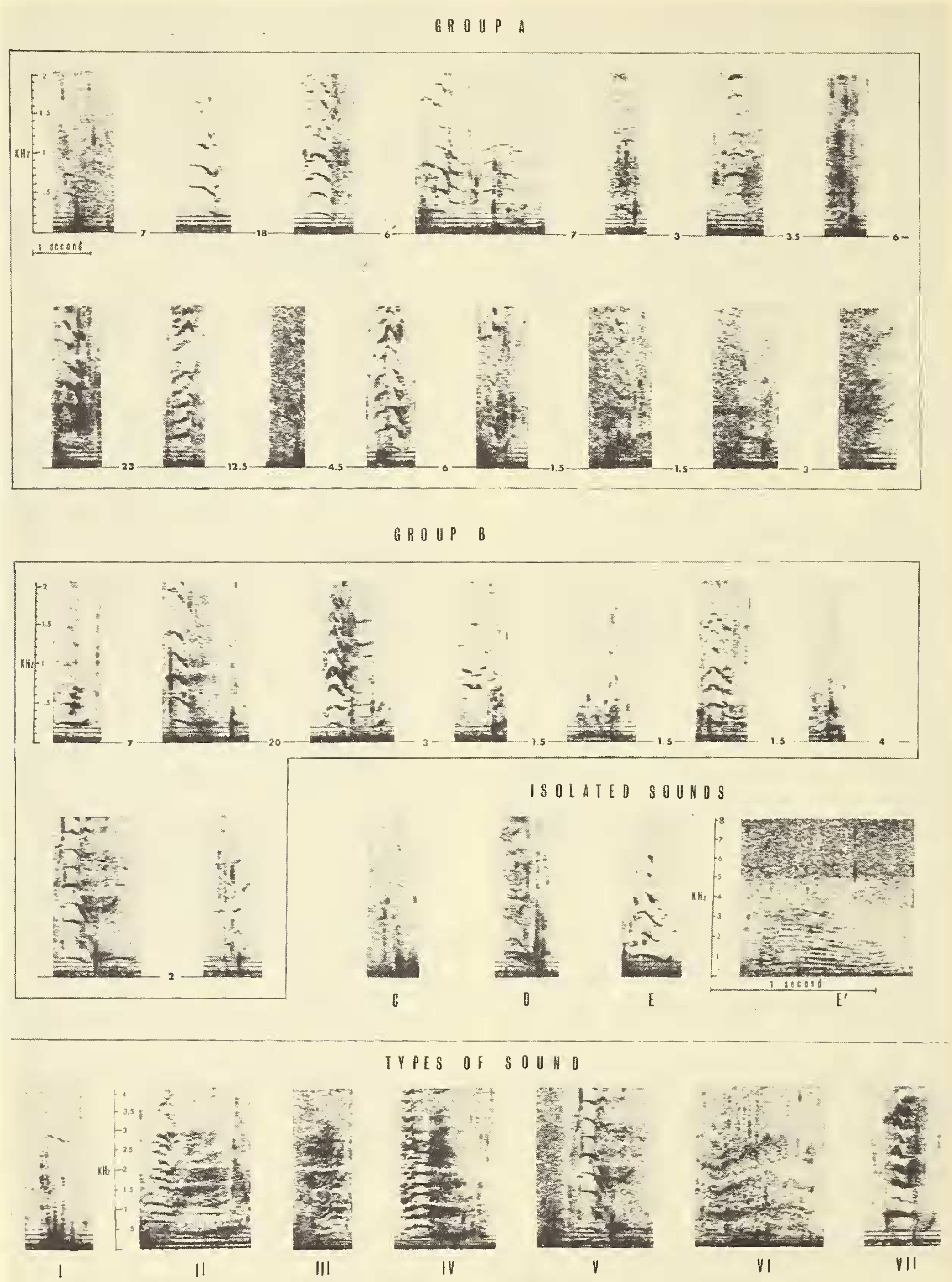
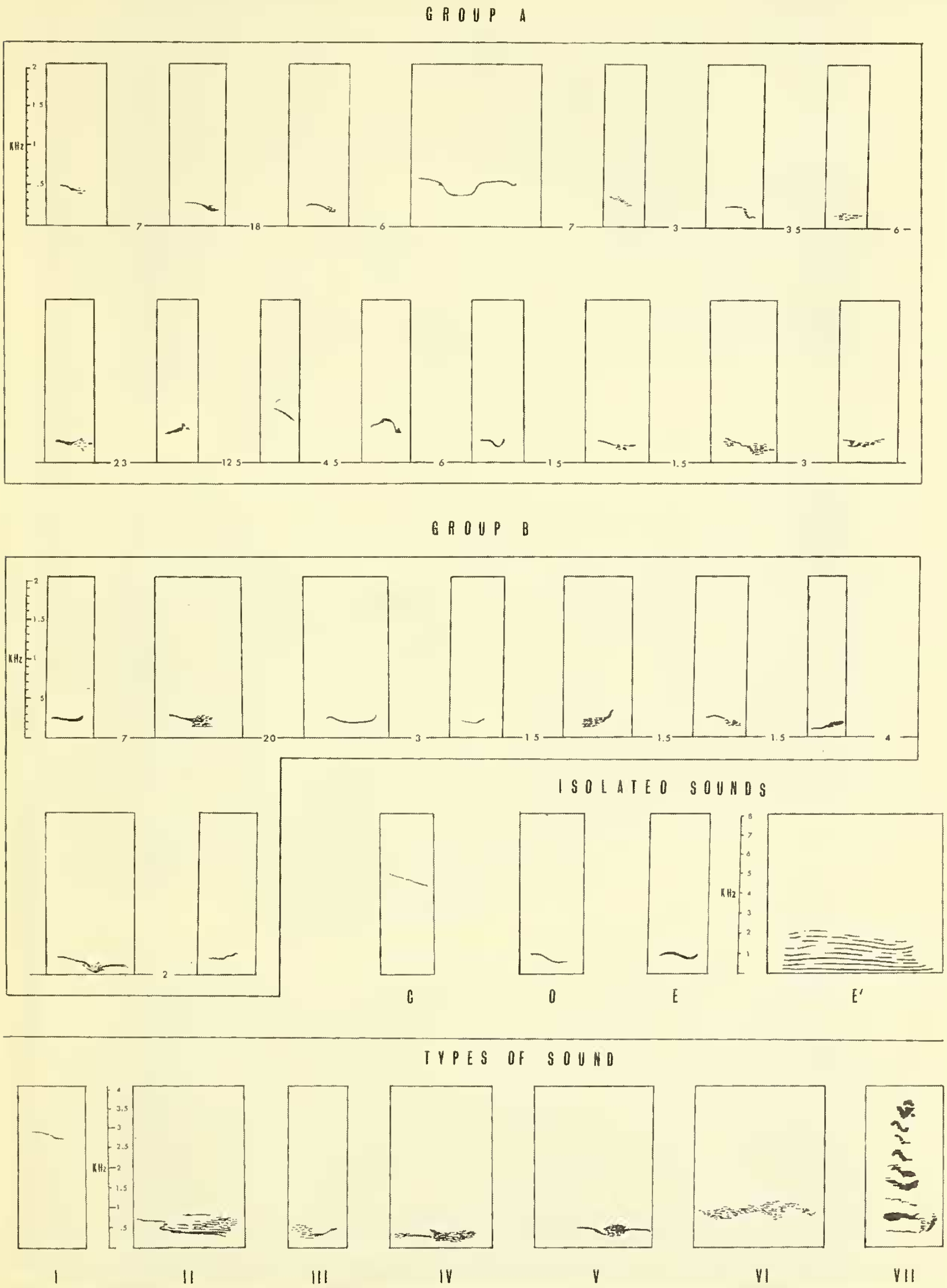


TEXT-FIGURE 1. Spectrograms of sounds recorded from right whales. Group A and Group B are two series of sounds presented in the order of their occurrence; the numbers between spectrograms indicate the duration in seconds of the silences between sounds. C, D, and E are characteristic single utterances surrounded by long silences. E and E′ are spectrograms of the same sound. The effective filter bandwidths are as follows: in E′ 45 Hz; in II, III, IV, and VI 22 Hz; and in all others 11 Hz. The bottom row (I-VII) is a selection of sounds to represent the variety of sounds made by right whales, and are drawn from different points in our records (see text). The scale preceding spectrogram II applies to examples II, III, IV, and VI.

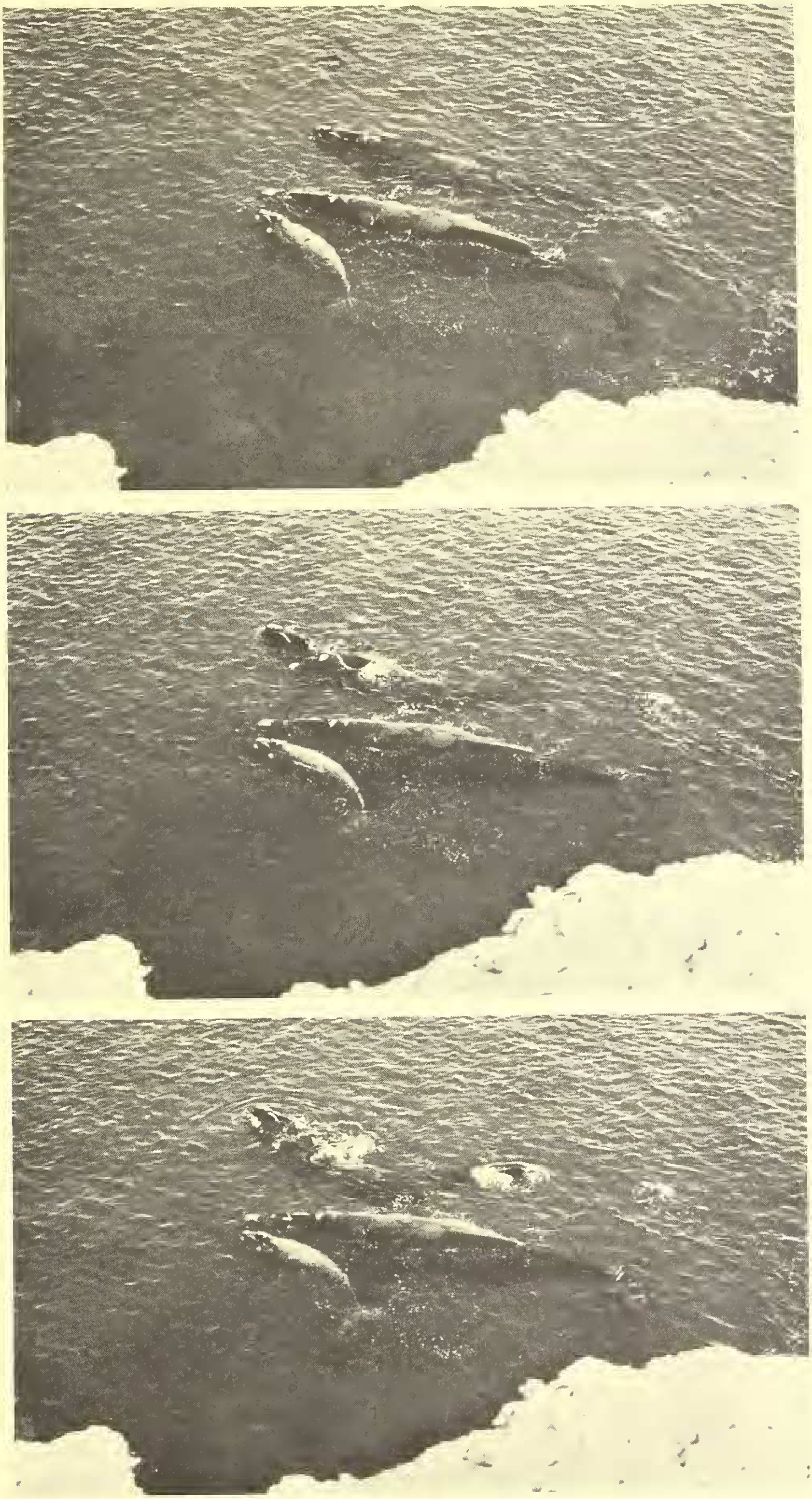


TEXT-FIGURE 2. A diagrammatic tracing of the spectrograms in Text-figure 1, omitting all but some of the components of the whale sounds (see text). The purpose here is to try to indicate the quality of the sounds when heard by the human ear. This is done by omitting harmonics and drawing just the principal frequency for moans and other somewhat tonal sounds. For atonal, pulsive, or rasping sounds, their many characteristic harmonics are included. The different types of sounds produced by right whales are more apparent from this presentation, but it is not intended to imply what features of these sound, if any, are attended to by the whales.

EXPLANATION OF THE PLATE

Plate I

Postural behavior often seen between two whales. This time it concerned a female accompanied by a calf being approached by a third whale. See text for explanation. Note that the calf is closer to shore than its mother; the white edge of a cliff is in the foreground. In our experience, females always kept their calves inshore of them or interposed themselves between the calf and any potential danger — a boat, a swimmer, another whale, etc. In A, the slick in the water above the female's tail indicates that she has made a single stroke with her tail. In B and C, the strange spinal flexures of the approaching whale are shown.



A

B

C